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Secretary of the Commission
U.S. Nuclear Regulatory Commission
ATTN: Docketing and Service Branch
Washington, D.C. 20555

Dear Sir:

Enclosed please find "Union of Concerned Scientists Comments on Advance Notice of Proposed Rulemaking: Consideration of Degraded or Melted Cores in Safety Regulation."

Very truly yours,

[signature]

Ellyn R. Weiss
General Counsel,
Union of Concerned Scientists

ERW/dmw
Enclosure

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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

DOMESTIC LICENSING OF PRODUCTION
AND UTILIZATION FACILITIES
10 CFR Part 50
Consideration of Degraded or Melted
Cores in Safety Regulation

UNION OF CONCERNED SCIENTISTS COMMENTS ON ADVANCE NOTICE OF PROPOSED RULEMAKING: CONSIDERATION OF DEGRADED OR MELTED CORES IN SAFETY REGULATION

Introduction and General Comments

These comments are submitted by the Union of Concerned Scientists, a non-profit public interest organization composed of scientists, engineers and other professionals, supported by the contributions of over 100,000 public sponsors nationwide. With headquarters in Cambridge, Massachusetts and offices in Washington, D.C., UCS concentrates its efforts in scientific and technical evaluation and public education in the areas of energy policy, nuclear safety and arms control.

UCS has published widely-disseminated technical work in these areas and has participated in numerous NRC proceedings.

UCS welcomes this proposed rulemaking, albeit belated. It has been our position for many years -- and one which we have communicated to NRC in a variety of forums -- that its historical exclusion of consideration of major reactor accidents from both safety and environmental reviews has no technically justifiable basis.

We will address ourselves below to the specific questions contained in the advance notice of proposed rulemaking. However, UCS believes that several key issues are either not raised by those questions or are implicitly assumed to be resolved when they should be open for consideration and review by the Commission.

The first of these is the basic question of whether the consequences from a severe reactor accident are tolerable at any frequency. These include short and long-term deaths, cancers and other health effects, property damage, permanent quarantining of land, and severe disruption of the U.S. economy. The consequences of the most serious accident analyzed in WASH-1400*, which is far from a worst-case scenario, included 3300 fatalities from acute radiation, 45,000 cancer deaths, 285,000 non-fatal illnesses, 5100

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* Derived from WASH-1400, Tables 5-7 and 5-8, Main Report, pp. 84-85.

genetic defects in the first generation born after the accident,* $14 billion in property damage, 3200 square miles requiring decontamination and 290 square miles essentially quarantined, requiring permanent relocation of all inhabitants. These figures do not include consideration of the consequences to the economy of less direct effects of an accident of this magnitude, including prominently its impact on electric power systems and on the national economy in general. If an accident with impacts even a fraction of this level occurred at a time when the U.S. was more dependent on nuclear energy than it is today, these consequences would themselves be staggering.

UCS believes that such consequences are clearly intolerable. Our positions in this proceeding flow from this conclusion. This conclusion also suggests that, at least for future plants, the Commission should take steps to ensure that the basic design of reactors incorporates features which would make a catastrophic accident genuinely incredible, barring deliberate acts of war or sabotage. The availability of this option is not reflected in the nature of the questions posed in this notice, which implicitly assume that current reactor designs form the starting point

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** This figure assumes continuing appearances of genetic defects for only 30 years. In fact, such defects would continue to appear for 4 to 5 generations.

of discussion, with add-on design features considered which are directed toward preventing and mitigating core damage and core melt accidents.

In contrast, UCS urges the Commission to consider mandating the following, at least for future plants:

1. Limitations on permissible power density, which would restrict the potential for core damage

2. Limitations on fission product inventory, which would restrict the potential consequences of core damage or melt

3. Use of cladding material other than zirconium, which would limit the potential for hydrogen generation

4. Increasing the size and strength of containments

The above actions would reverse current trends of increasing power density, fuel burnup and reactor size, all of which have had the effect of continually reducing the margin between normal plant operating conditions and the onset of serious damage. The changes UCS supports would greatly enlarge that margin, virtually eliminating the potential for certain accidents, dramatically increasing the amount of time that a core could withstand interruptions in coolant flow and making it far easier to cool a damaged core. Such a design would also substantially limit the consequences of even the most severe possible accident. Although it would involve a trade-off in efficiency, the theoretical disadvantage of the design would certainly be offset to some degree by decreases in down-time attributable to the size, complexity and sensitivity of current plants.

As these comments suggest, UCS believes that, at least for future plants, the highest priority should be given to preventing accidents by decreasing the sensitivity of the plants to design and operational errors - building in a margin of safety that would make a catastrophic accident close to genuinely incredible and limiting the amount of radioactive material in each plant. Obviously, to the extent that such a design would serve to preclude high-consequence accidents, relatively less effort would need to be devoted to accident mitigation.

For current plant designs, there is less freedom to increase the margin of safety. The principles of defense in depth dictate greatly increased attention to both prevention and mitigation of core damage and core melt. It should be noted that, as currently interpreted by NRC, defense-in-depth does not provide genuinely independent barriers to the release of radioactive material. It is frequently claimed that the fuel cladding, the emergency core cooling system and the containment building constitute independent levels of defense. However, the proper functioning of ECCS is assumed as a basis for plant design. Failure of ECCS could result in failure of both the cladding and the containment. Thus, they are clearly not independent. In this rulemaking, the Comm[illegible]on should mandate truly independent levels of defense-in-depth.

Finally, UCS urges the Commission to resist permitting this rulemaking to be driven by the mistakes of the past. The issue of backfitting currently operating plants should be clearly separated from the requirements for new plants in order to ensure that financial constraints associated with backfitting do not assume an overriding importance.

Responses to Specific Questions

The following responses are based on the assumption implicit in the questions that the starting point for analysis is current plant designs. As discussed above, UCS believes that the Commission should not so limit itself, but should require the reversal of current trends in design which tend to make plants inherently more dangerous and sensitive.

1. If one assumes that current designs will remain basically unchanged in the future, the consequences of a core damage/core melt accident can be extremely severe, as noted above. These consequences can be substantially

mitigated in two general ways:

a. The amount of material released can be reduced by such measures as containment spray, filtered containment venting, and reduced fuel burnup levels.

b. The release can be delayed and perhaps largely prevented by, for example core catchers and filtered containment venting.

This is not an exhaustive listing of possible design changes. If properly designed -- that is, designed so that the systems are independent and their operation will not itself cause a hazard to safety -- there is no reason why such systems should have significant negative safety impact. In any case, the advantages of properly designed systems would certainly far outweigh any speculative disadvantages.

2. There can be little serious dispute that NRC should explicitly consider accidents at least as severe as TMI-2 in safety reviews. The position currently being taken by the NRC staff in the TMI-1 Restart hearings - that another core damage accident is incredible - is preposterous. The criteria for acceptability should be conformance with the functional requirements which should result from this rulemaking.

3. Yes, core melt as well as core damage accidents should be specifically evaluated in safety reviews. It should

be emphasized that there is no technically justifiable basis for refusing to evaluate these accidents; they are far from incredible.

We also see no reason why worst case assumptions should not be used.

4. The question appears to be inquiring about the possibility of using a variety of mitigative measures based on a sort of "sliding scale" of probability of accident severity. In our view, it is a premature and probably ill-conceived inquiry. The uncertainties associated with estimating accident probabilities are so great as to make the effort useless for this purpose. In any case, until the record is fully developed on the systems that are available to prevent and mitigate major accidents and the benefits associated with those systems, the question cannot be addressed.

5. Unless engineered safety features are independent and diverse in both function and equipment, the analyses of accidents beyond the current design basis must assume that they fail. For example, if all ECCS trains use the same equipment and function in the same manner, ECCS failure must be assumed.

Currently, safety systems are designed so as to permit the operator to terminate their operation before their safety function has been accomplished. For example, as during the TMI-2 accident, the operator can throttle ECCS before the core is cooled. UCS believes that premature operator interference with safety systems should be precluded by plant design. This is a position which we have defended in the ongoing TMI-1 Restart hearings. Unless and until NRC adopts this approach, it should analyze the consequences of operator error by assuming that, if the operator decides upon a course of action such as terminating ECCS or overriding containment isolation, every action which can be taken to achieve that result will be taken. In other words, the basic error in judgment - the decision to terminate ECCS - should be viewed as one error, regardless of the number of steps required to achieve the erroneous objective.

With respect to a limitation on multiple failure assumptions, it is UCS's view that until adverse systems interactions can be eliminated through plant-specific systems interaction analyses, use of the single failure criterion is unjustifiable.

6. Filtered containment venting should be required. UCS is unable to evaluate questions of specific functional requirements at this preliminary stage of the proceeding. With regard to the question posed concerning "potential

increase in risk...from incidents such as inadvertent operation..." we find it difficult to hypothesize the scenario that would result in a greater risk from the filtered venting system than from no system.

7. Under current conditions, NRC should require systems which are capable of controlling 100% of the amount of hydrogen that can be generated in a damaged core. It is our view that, in the longer term, serious investigation should be given to using cladding material other than zirconium. Insufficient information is available at this stage to enable us to determine the relative advantages and disadvantages of hydrogen suppression versus controlled burning. Finally, in evaluating containment strength, credit should be given only for the design pressure capability, not some theoretically calculated "potential" capability, unless licensees are willing to do periodic tests at the higher level.

9. Core catchers have the potential to provide significant benefits in accident mitigation and we believe that they should be required at a minimum for sites with relatively high surrounding population densities. Both forced and natural cooling should be provided. The choice between a permanent core retention system or a delaying system could depend on site-specific factors such as the feasibility of evacuation

and the proximity of the plant to rivers and aquifers. Given current designs, containment type is not a significant factor.

10. These systems should be required to function at higher radiation levels and be qualified to function for a generally more severe environment than the current environmental qualification envelope. In addition, it is UCS's position that a method of long-term forced cooling of the core should be provided which is capable of operating at the full temperature and pressure rating of the primary system. Residual heat removal systems can be modified to achieve this objective.

With respect to containment drainage, it is our view that the containment should be designed and the equipment within it arranged so that it can withstand flooding at least to the top of the reactor vessel.

11. Improvement in operator training and procedures cannot be viewed as an alternative to design improvements, even for design basis accidents. For events beyond the current design basis and therefore, by definition, unanticipated by the plant designers and beyond the design capability of the safety systems, reliance on operator training is patently absurd.

12. An independent decay heat removal system capable of operating at full primary system temperature and pressure

should be required. An example can be found in West German designs, which provide a third completely independent, bunkered cooling system, with its own power supply and auxiliary systems.

13. UCS does not favor use of the makeup system to serve a dual function. As a general proposition, systems used in normal plant operation should not be used to perform safety functions. Such designs create potential adverse systems interactions; the failure of the dual-purpose system can both cause an accident and degrade the plant's ability to cope with the same accident. In addition, they remove a level of defense-in-depth because they are not independent and create design conflicts which are not satisfactorily resolvable.

14. Systems for preventing and mitigating core damage and core melt accidents should be judged by criteria as stringent as those applied to engineered safety features on a conservative analytical basis. Although the probability of these accidents may be lower than those currently within the design basis, their consequences are far greater. Therefore, UCS sees no justification for relaxation of such criteria as redundancy, diversity, testability, etc.

15. UCS believes that quantitative probabilistic risk analysis cannot be relied upon in determining the design criteria and reliability requirements for the features under consideration. The well-established inability of such analyses to account for common mode failure or to predict all possible accident sequences results in margins of uncertainty so great as to make them essentiall" useless for determining accident probabilities.

Qualitative risk assessment may be a useful tool in comparing the relative benefits of design changes, although its value is limited because of the inability to assess the importance of these unforseen factors such as common-mode failures and operator errors.

16. In weighing the costs against the benefits of new systems, both the direct and indirect costs of the most severe accident must be explicitly considered. As discussed above, these include both health effects and the economic impact of the accident, including its broader implications for the national economy. It is only appropriate to compare nuclear risks to the risks of other methods of generating electricity, not to such completely unrelated and extrinsic risks as those associated with automobile accidents.

In addition, it should be determined at the outset that certain risks are unacceptable <u>per se</u>. For example, there are no benefits associated with nuclear power that can balance the real risk of 250,000 cancer deaths and the permanent loss of 290 square miles. Any cost to prevent or mitigate consequences of that level is justified, including the cost of disapproving operation of a facility posing such a risk.

18. There is an obvious interrelationship between emergency planning and plant design. It is UCS's position, expressed in the emergency planning rulemaking, that the current rule is based on an essentially arbitrary and unsupportable use of far less than worst-case accident assumptions. A major reactor accident could cause death and illness well beyond the 10-mile emergency planning limit. If plants were designed to prevent such consequences by reducing power density and limiting fission product inventory, for example, emergency planning zones could be adjusted to reflect a real reduction in risk.